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**TORO MEMORANDUM**

October 23, 1989

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**Subject: Final Report - UNIQ Mobility Electric Drive Greensmower**

**Review of Project Goals**

The project was originated to install a high tech electric drive system on the GR3000. Proprietary UNIQ technology brushless D.C. alternator and motors and a state of the art electronic controller were used. The hydraulic lift and lower were retained. The Kohler engine was retained, but was used to belt drive the alternator. Electric reel drive was provided via belt drive to the cutting units, and electric traction drive was provided via planetary drive to the wheels.

The goal of the project was to demonstrate that the modified electric drive greensmower could operate virtually identically to the current hydraulic drive machine. Toro also negotiated the exclusive use of this technology in the turf business subject to some conditions of continuing to utilize the technology.

**Review of the Project Results**

A production GR3000 was sent to UNIQ in Englewood, CO, where it was modified to remove the hydraulic drive systems which would no longer be used, and to install the simple pump and valve for the lift and lower which were still hydraulic. The electric drive components were built and installed in the unit.

The initial evaluation of the unit was in December 1987 in Colorado. These first test results were somewhat discouraging since the unit could not climb a 10% grade, and would noticeably slow down at any incline at all. Cutting unit speed varied widely with load. It was apparent that not enough power was available to the traction circuit and that some speed regulation was required. In an attempt to increase the power output, the voltage was increased and part of the controller failed. The noise level of the electric devices was quite high.

The machine was modified by UNIQ to improve the shortcomings. Traction power was increased, and speed regulation was installed. However, the reel speed still varied greatly with load. It was discovered that the motor efficiency was significantly lower than promised.

UNIQ built new reel motors with higher efficiency using 6 slots per pole rather than the previous 3 slots per pole. Speed regulation was added to the reel drive system, and the machine was again evaluated in December 1988.

The engine pulled down when mowing on the green. The engine did not put out enough power to both mow and drive at the same time. However, the speed regulation of the reel motors was good. The traction system seemed to work well. UNIQ checked everything out and consultant John Beattie had the engine tuned up.

The cost was estimated by UNIQ for the system installed on the machine. The estimated cost for the electric drive system in production volumes was about \$3000. The cost of the hydraulic system which was being replaced was about \$1200. Therefore, the electric system would be a major cost increase.

The machine was evaluated again in May 1989. Even though UNIQ was confident that the shortcomings had been addressed, the machine operated in the same manner in which it had previously. The engine did not have enough power to both drive and mow at the same time. It was determined that the machine should be sent to Minneapolis so that Toro could place it in a lab cell and fully instrument it so that simultaneous data could be collected on all components to determine actual efficiencies.

In September 1989, the machine was instrumented and tested in the lab at Lyndale. The numbers were very discouraging, but in line with previous observations, with the alternator efficiency in the 60% range, the traction motors less than 45%, and the reel motors 70 - 73%. When allowance is made for almost 1 Hp loss for the cooling fans, this leaves the system efficiency at less than 35%, less than half of the promised 70%.

## Conclusion

The efficiency values measured are obviously a major departure from the planned and required values. UNIQ has been struggling with these issues for about 2 years, and at this point shows little hope of resolving the issues. The UNIQ technology is quite different than other electric drive systems which have already been shown to be more efficient and reliable and less expensive than the UNIQ system. Because of these reasons, it is the decision of Toro to discontinue development work with UNIQ at this time. There are other much more promising electric drive systems which will be pursued as time and priorities warrant.